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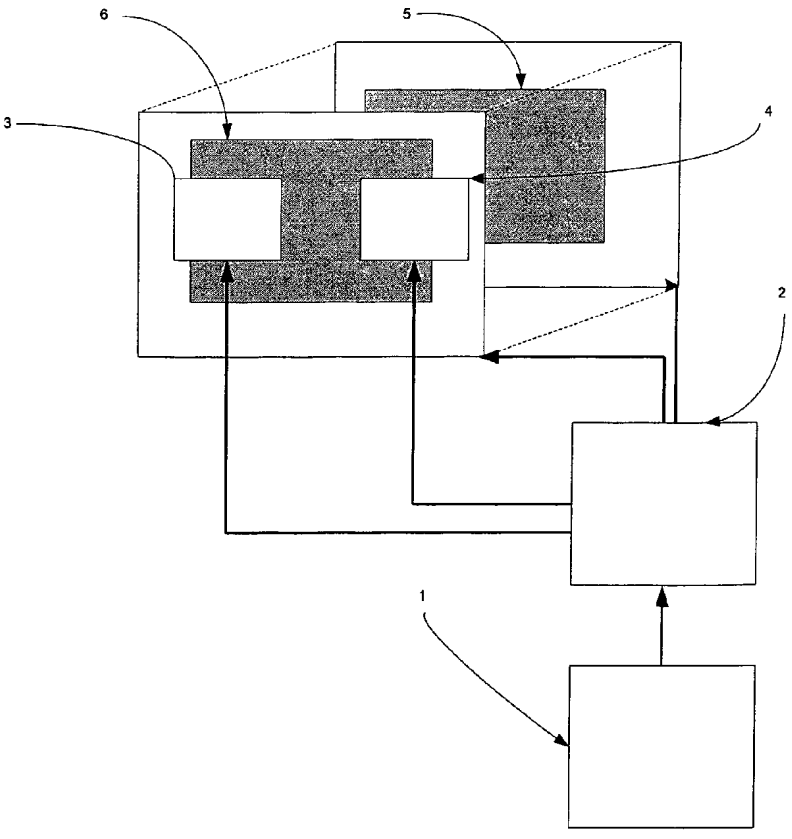
(54) Title: DUAL LAYER STEREOSCOPIC LIQUID CRYSTAL DISPLAY



(57) Abstract: A stereoscopic viewing device comprising; a multi layer device and at least one binocular shutter device which controls the images presented to each eye by means of blocking light presented to each eye; where said multi layer display device and binocular shutter device(s) are designed to work in conjunction whereby the images intended for right and left eye are displayed on different layers of the multi layer display device in a time sequential manner and the at least one binocular shutter device presents (present) the image(s) intended for the right eye to that eye by blocking light presented to the right eye and presents (present) the image(s) intended for the right eye to that eye by blocking light presented to the left eye.

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ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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DUAL LAYER STEREOSCOPIC LIQUID CRYSTAL DISPLAY

TECHNICAL FIELD

This invention relates to an improved imaging system, preferably implemented with or using a multi layer or multi screen display. Preferably the present invention may employ two separate imaging layers in conjunction with synchronized shutters placed in front of the left and right eye of the viewer(s).

BACKGROUND ART

Multi-layered display (MLD) units provide a significant improvement over existing single layer display (SLD) units or displays. MLD units may be used to nest display content over spacially displaced or stacked layers to provide an enhanced mechanism for information absorption and analysis by users. An example of an existing multi-layer display is discussed for example in WO9942889A.

Reference throughout this specification will also be made to the present invention being used in conjunction with multi-layer displays of the type disclosed in WO9942889A. However, those skilled in the art should appreciate that the present invention may also be adapted for use with other types of MLD units and reference to the above only throughout this specification should in no way be seen as limiting.

There are two main types of displays used in computer monitors, passive matrix and active matrix. Passive-matrix displays use a simple grid to supply the charge to a

particular pixel on the display. Creating the grid starts with two glass layers called substrates. One substrate is given columns and the other is given rows made from a transparent conductive material. This is usually indium tin oxide. The rows or columns are connected to integrated circuits that control when a charge is sent down a particular column or row. The opto-electrical material, which changes optical state when an electric field is supplied, is sandwiched between the two glass substrates. A pixel is defined as the smallest resolvable area of an image, either on a screen or stored in memory. Each pixel in a monochrome image has its own brightness, from 0 for black to the maximum value (e.g. 255 for an eight-bit pixel) for white. In a colour image, each pixel has its own brightness and colour, usually represented as a triple of red, green and blue intensities. To turn on a pixel, the integrated circuit sends a charge down the correct column of one substrate and a ground activated on the correct row of the other. The row and column intersect at the designated pixel and that delivers the voltage change the electro-optical material at that pixel.

The passive matrix system has significant drawbacks, notably slow response time and imprecise voltage control. Response time refers to the displays ability to refresh the image displayed. imprecise voltage control hinders the passive matrix's ability to influence only one pixel at a time. When voltage is applied to change one pixel, the pixels around it also partially change, which makes images appear fuzzy and lacking in contrast.

Active-matrix displays depend on thin film transistors (TFT). Thin film transistors are tiny switching transistors and capacitors. They are arranged in a matrix on a glass substrate. To address a particular pixel, the proper row is switched on, and then a charge is sent down the correct column. Since all of the other rows that the column intersects are turned off, only the capacitor at the designated pixel receives a charge. The capacitor is able to hold the charge until the next refresh cycle. And if the amount of voltage supplied to the crystal is carefully controlled, it can be made to untwist only

enough to allow some light through. By doing this in very exact, very small increments, displays can create a grey scale. Most displays today offer 256 levels of brightness per pixel.

A display that can show colours must have three sub pixels with red, green and blue colour filters to create each colour pixel. Through the careful control and variation of the voltage applied, the intensity of each subpixel can range over 256 shades. Combining the sub pixels produces a possible palette of 16.8 million colours (256 shades of red x 256 shades of green x 256 shades of blue).

Displays employ several variations of liquid crystal technology, including super twisted nematics, dual scan twisted nematics, ferroelectric liquid crystal and surface stabilized ferroelectric liquid crystal. They can be lit using ambient light in which case they are termed as reflective, or backlit and termed transmissive. There are also emissive technologies such as Organic Light Emitting diodes which are addressed in the same manner as displays. These devices are described hereafter as image planes.

At present there exist methods to produce displays where several imaging planes are stacked with set distances between them. These imaging planes may also be stacked as closely as possible. In a preferred embodiment these displays consist of a high-brightened backlight, a rear image panel which is usually an active matrix, colour display, a diffuser and a front image plane, which are laminated to form a stack. There are generally colour filter stripes as mentioned above, and a black matrix on each display which defines the borders of the pixels. However it should be appreciated that the following discussion applies to all image planes that are addressed by passive or active matrices or have colour filters arranged in any periodic pattern.

DISCLOSURE OF INVENTION

Channeling elements may give a viewer binocular depth cues which the viewer uses to perceive the distance from an object displayed. As the viewers eyes are displaced from one another, they normally view an image from slightly different angles, and the brain in turn processes both images to perceive a distance or range for the object in question. in a display system a channeling element or elements can be used to present varying images to each of the observers eyes, giving the impression that the object is three dimensional. These images may be produced from different camera vantage points in the physical world, or may be produced by different camera vantage points within a 3d image rendering system.

Accordingly a first aspect of the present invention consists of a stereoscopic viewing device comprising;

i) a multi layer display device

ii) and at least one binocular shutter device which controls the images presented to each eye by means of blocking light presented to each eye;

where said multi layer display device and binocular shutter device(s) are designed to work in conjunction whereby the images intended for right and left eye are displayed on different layers of the multi layer display device in a time sequential manner and the at least one binocular shutter device presents (present) the image(s) intended for the left eye to that eye by blocking light presented to the right eye and presents (present) the image(s) intended for the right eye to that eye by blocking light presented to the left eye.

As such the present invention consists of a multi layer display, in conjunction with shutters applied that can be switched between blocking and passing light to each eye of

a viewer, where the shutters form channeling elements to present separate images to separate eyes.

Accordingly a further aspect of the current invention consists of a stereoscopic viewing device as described above where the at least one binocular shutter device presents (present) no images to the viewer at each point in time between each image being presented to each eye.

Accordingly a further aspect of the current invention comprises a stereoscopic viewing device as described above where no image is displayed on the multi layer display device at each point in time between each image being presented to each eye.

As such the present invention consists of a multiple layered display, with as little distance as possible between the imaging planes, in conjunction with shutters applied that can be switched between blocking and passing light to each eye of a viewer, and the timing between the two imaging layers or devices is adjusted such that images are out of phase. If the images are out of phase, as one image is being written to the first imaging plane, an image is being deleted from the second imaging plane. In addition as an image is being written to the first image plane, the shutter to the left eye is opened and as an image is being written to the second image plane the shutter to the right eye is open or vice versa. Also both shutters may be closed or semi-closed, or the backlight system turned off for a small time interval to prevent cross talk which is an undesirable artifact of stereoscopic imaging where an image presented to the left eye is partially presented to the right eye and vice versa resulting in depth inversion. This means the effective presented frame rate, which is the rate at which separate images may be written to the display, can be twice as fast as conventional liquid crystal technology, making it usable for presenting temporally modulated images in standard configuration.

It is convenient to have a single signal cable exiting from an image signal source, such as a computer graphics adaptor, and a central point is required to ensure that signals to both the image layers and shutter glasses are produced and synchronized correctly. Such a function may be performed by a single, housed, electronic circuit where the output from the graphics adaptor is connected and output signals to the imaging planes and eye shutters are produced.

Preferably the binocular shutter device is attached to a CPU or other controlling device which can co-ordinate the timing associated with presentation of images to eyes.

Preferably the binocular shutter device blocks light through the use of an LCDs or alternatively polarisers on each eye which are able to block light or effectively block light.

BRIEF DESCRIPTION OF DRAWINGS

Further aspects of the present invention will become apparent from the following description which is given by way of example only and with reference to the accompanying drawings in which:

Figure 1 Figure 1 illustrates a block diagram of the electronic system used to drive the stereoscopic display device.

Figure 2 illustrates timing diagrams of the decoded signals used to drive the stereoscopic display device

Figure 3 illustrates timing diagrams how composite images can be assembled together to provide the image to be displayed and their subsequent display.

BEST MODES FOR CARRYING OUT THE INVENTION

Figure 1 illustrates a block diagram of the electronic system used to drive the stereoscopic display device. A signal (1) encoding images for both screens is sent to a decoder (2) which decodes the signal and sends separate signals to the shutter to the left eye(3), the shutter to the right eye(4), the rear display(5) and the front display(6). It should be appreciated that the shutter signals may be reproduced and sent to shutters used by multiple observers.

Figure 2 illustrates timing diagrams of the decoded signals used to display 3-D images using the stereoscopic display device. A combined signal which may be multiplexed is made up of the signal to the right eye shutter (7), the signal to the left eye shutter (8), the signal or frame(s) sent to the rear display (9) and the signal or frames sent to the front display (10). Additionally in a preferred embodiment an on off signal is sent to the shutter and/or the display (11). Time is on the horizontal axis and voltage on the vertical axis.

Figure 3 illustrates how composite images can be assembled together to provide the image to be displayed and then be subsequently displayed on a stereoscopic display device.

In the instance shown, an image of a cube (12) is to be displayed. Two separate source images or pictures can be recorded (13 and 14) to give the view which is to be presented to each of the left eye and right eyes (15 and 16) of the observer.

The first source image is then displayed on the rear image plane (17) while the shutter (18) to the right eye (19) is opened and the shutter (20) to the left eye (21) is closed, and then the second source image is displayed to the second image plane (22) while the shutter to the right eye is opened and the shutter to the left eye is closed. Both shutters may be closed or the backlight dimmed for some period of time to prevent cross talk. This composite final image, will appear to the observer to originate behind and/or in

front of the display screen in which it is presented, and to have actual depth or three dimensional qualities.

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WHAT WE CLAIM IS

1. A stereoscopic viewing device comprising;

   i) a multi layer display device

   ii) and at least one binocular shutter device which controls the images presented to each eye by means of blocking light presented to each eye;

   where said multi layer display device and binocular shutter device(s) are designed to work in conjunction whereby the images intended for right and left eye are displayed on different layers of the multi layer display device in a time sequential manner and the at least one binocular shutter device presents (present) the image(s) intended for the left eye to that eye by blocking light presented to the right eye and presents (present) the image(s) intended for the right eye to that eye by blocking light presented to the left eye.

2. A stereoscopic viewing device as described in claim 1 where the at least one binocular shutter device presents (present) no image to the viewer at each point in time between each image being presented to each eye.

3. A stereoscopic viewing device as described in claim 1 where no image is displayed on the multi layer display device at each point in time between each image being presented to each eye.

4. A stereoscopic viewing device as described in claims 2 and 3 in combination.

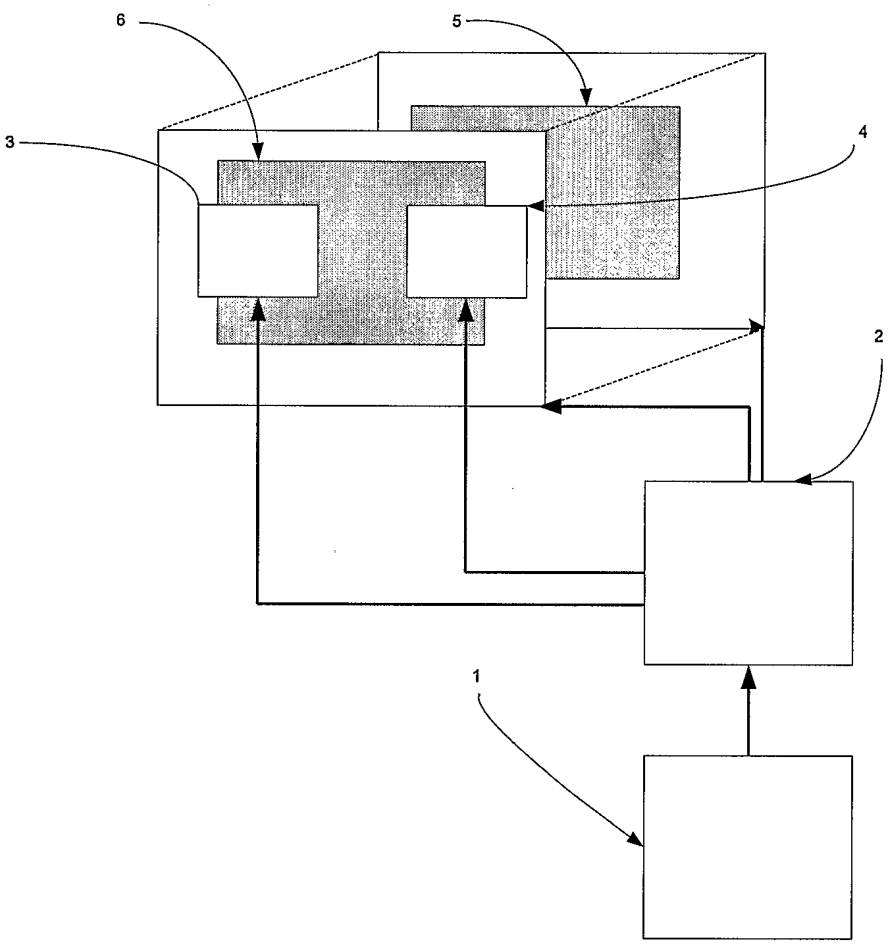

FIGURE 1

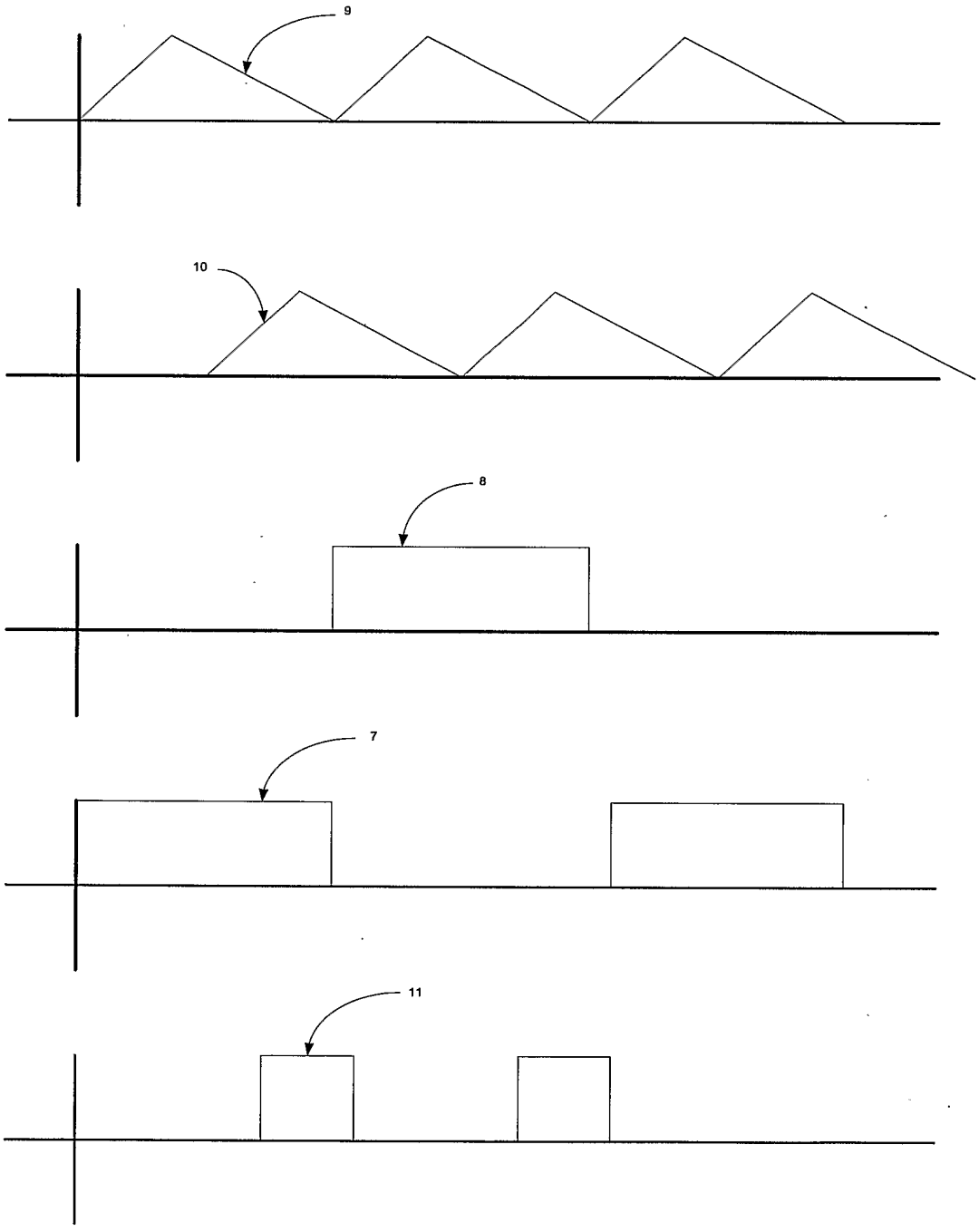

FIGURE 2

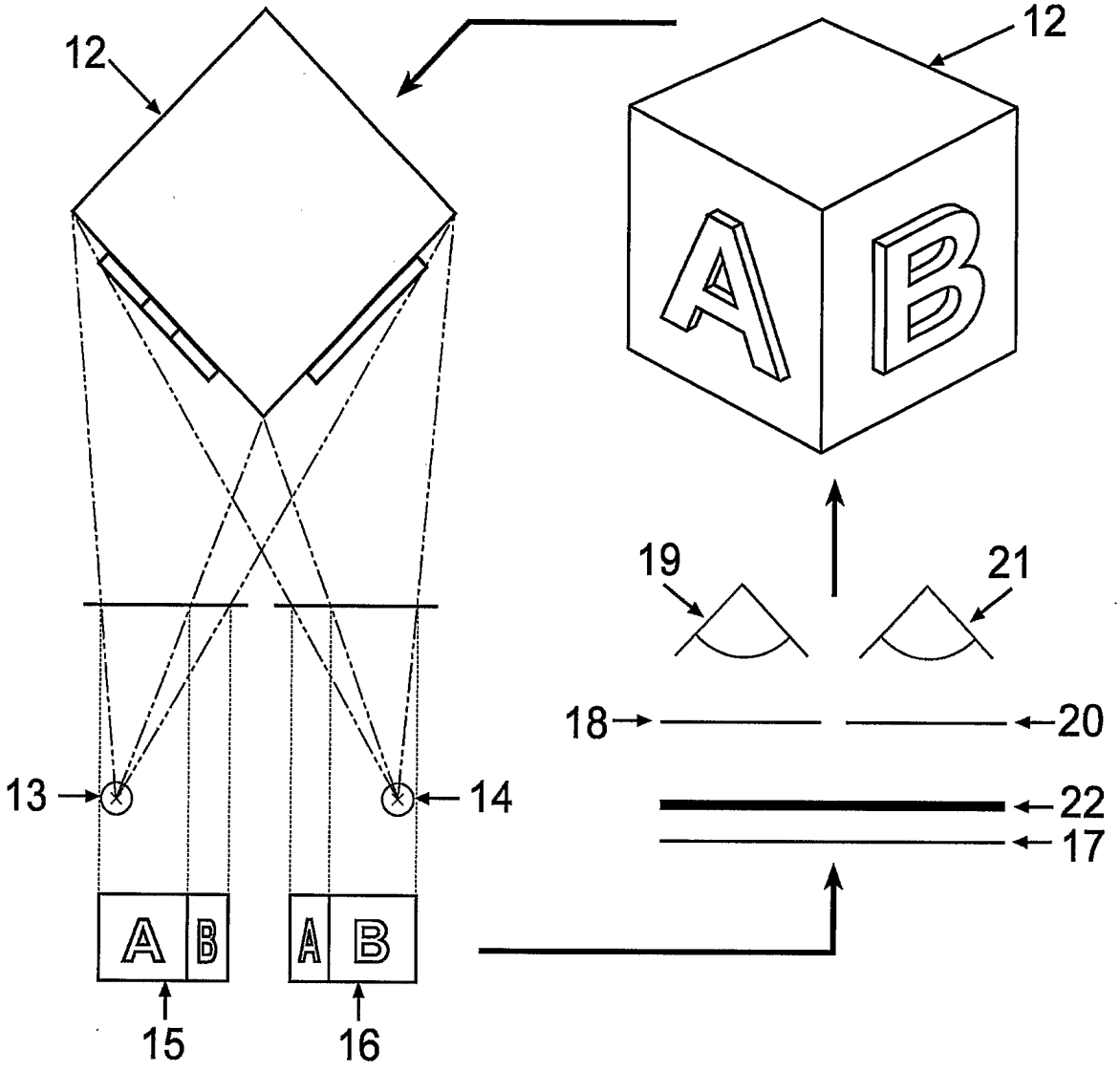

FIGURE 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ03/00126

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: G02B 27/22, G02F 1/1347, H04N 13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
DWPI, JAPIO Keywords: stereo, depth, 3d, 3 dim, three dim, G02B 27/22, 27/24, H04N 13/-, H04N 15/-; multi layer, dual layer; screen, display; superpos, overla, multiple, front, back, rear; shutter, switch, alternat, block, sequential; lcd, liquid crystal; image; tim

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 19510671 A (AVGOUSTINOS) 2 October 1996 Whole document	1-4
A	Patent Abstracts of Japan, JP 2002-010300 A (OKAJIMA KATSUNORI SORITSUDOREI KENKYUSHO:KK) 11 January 2002 Abstract	1-4
A	Derwent Abstract Accession No. 2000-040904/04, Classes P81, V07, EP 959377 A (NIPPON TELEGRAPH & TELEPHONE CORP) 24 November 1999 Abstract	1-4

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 October 2003	22 OCT 2003
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **MICHAEL HALL** Telephone No : (02) 6283 2474

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ03/00126

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
DE	19510671	NONE					
JP	2002010300	NONE					
EP	0959377	JP	2000115812	JP	2000134643	JP	2000156876
		JP	2000214413	JP	2000261832	JP	2001119725
		US	6525699	US	2003071765	US	2003080923

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